Durability Studies On Concrete With Fly Ash & Ggbs

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ABSTRACT

Durability of concrete is defined as its ability to resist weathering action, chemical attack, abrasion or any other process of detoriation. It also includes the effects of quality and serviceability of concrete when exposed to sulphate and chloride attacks.

Fly ash and Ground Granulated Burnt Slag (GGBS) are chosen mainly based on the criteria of cost and their durable qualities.,

Not only this, Environmental pollution can also be decreased to some extent because the emission of harmful gases like carbon monoxide & carbon dioxide are very limited.

In this paper our study is mainly confined to evaluation of changes in both compressive strength and weight reduction in five different mixes of M30 Grade namely conventional aggregate concrete (CAC), concrete made by replacing 20% of cement by Fly Ash (FAC_1), concrete made by replacing 40% of cement by Fly Ash (FAC_2), concrete made by replacing 20% replacement of cement by GGBS (GAC_1) and concrete made by replacing 40% replacement of cement by GGBS (GAC_2).

The effect of 1% of H_2SO_4 and sea water on these concrete mixes are determined by immersing these cubes for 7days, 28days, 60days in above solutions and the respective changes in both compressive strength and weight reduction had observed and up to a major extent we can conclude concretes made by that Fly Ash and GGBS had good strength and durable properties comparison to conventional aggregate in severe Environment.

Keywords: Durability, Flyash, GGBS, Strength, Weight Changes, CAC, FAC_1, FAC_2, GAC_1, GAC_2.

I. INTRODUCTION

Now-a-days the most suitable and widely used construction material is concrete. This building material, until these days, went through lots of developments. The definition of concrete is the mixture of cement, water, additives or sometimes super-plasticizers. It is artificial material. In the beginning it is soft, ductile or fluid, and gradually will be solid. We can consider this building material as an artificial stone. The most important part of concrete is cement. The production process of this raw material produces a lot of CO2. It is well known, that CO2 emission initiates harmful environmental changes. Nowadays researchers make efforts to minimize industrial emission of CO_2.

The most effective way to decrease the CO2 emission of cement industry, is to substitute a proportion of cement with other materials. These materials called supplementary cementing materials (SCM's). Usually used supplementary cementing materials are Ground Granulated Blast Furnace Slag (GGBS), Fly Ash (FA), Silica Fume (SF), Trass or Metakaolin (MK).These are typically industrial by-products, hence the application of SCM's results less CO2 during cement production. The SCM's provide other advantages and that is why the usage in the concrete technology is more and more general. The aim of our study is to get acquainted with these SCM's and to examine some features. The most interesting feature is to increase chemical resistance of concrete. We will focus in our examinations on GGBS and FA. In our scientific experiments we examine the influence of SCM's on weight loss and on the strength also. . In this study we describe the results of examinations and conclusions with GGBS & FA. We present the experimental program the further activities and works.

1.1 Durability

A long service life is considered synonymous with durability. Since durability under one set of conditions does not necessarily mean durability under another, it is customary to include a general reference to the environment when defining durability. According to ACI Committee 201, durability of Portland cement concrete is defined as its ability to resist weathering action, chemical attack, abrasion, or any other process of deterioration; that is, durable concrete will retain its original form, quality, and serviceability when exposed to its environment. No material is inherently durable; as a result of environmental interactions the microstructure and, consequently, the properties of materials change with time. A material is assumed to reach the end of service life when its properties under given conditions of use have deteriorated to an extent that the continuing use of the material is ruled either unsafe or uneconomical.

1.2 Environmental Related Causes of Concrete Durability Problems

Durability problems related to environmental causes include the following: steel corrosion, delamination, cracking, carbonation, sulphate attack, chemical attack, scaling, spalling, abrasion and cavitation.

Important degradation mechanisms in concrete structures include the following:

1. Freeze-thaw damage (physical effects, weathering).
2. Alkali-aggregate reactions (chemical effects).
3. Sulfate attack (chemical effects).
4. Microbiological induced attack (chemical effects).
5. Corrosion of reinforcing steel embedded in concrete (chemical effects).
a) carbonation of concrete
b) chloride induced
6. Abrasion (physical effects).
7. Mechanical loads (physical effects).

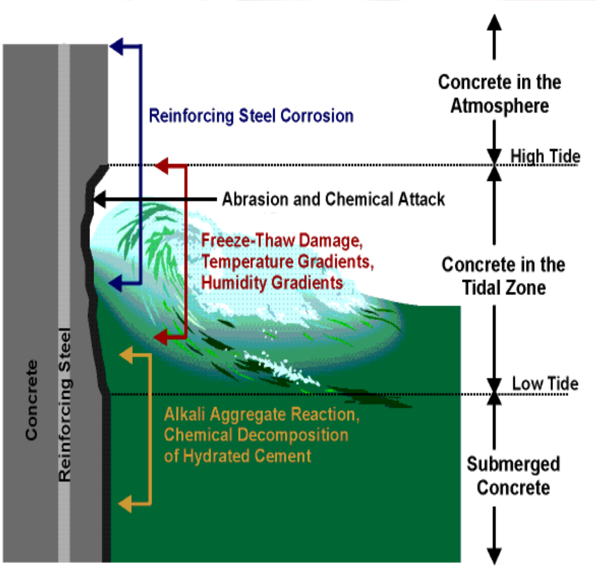

fig1: Degradation mechanisms in concrete structures

1.3 Sulphate Attack

Most soils contain some sulphate in the form of calcium, sodium, potassium and magnesium. They occur in soil or ground water. Because of solubility of calcium sulphate is low, ground waters contain more of other sulphates and less of calcium sulphate. Ammonium sulphate is frequently present in agricultural soil and water from the use of fertilizers or from sewage and industrial effluents. Decay of organic matters in marshy land, shallow lakes often leads to the formation of H_2S, in which can be transformed in to sulphuric acid by bacterial action. Water used in concrete cooling towers can also be a potential source of sulphate attack on concrete. Therefore sulphate attack is a common occurrence in natural or industrial situations.

Solid sulphates do not attack the concrete severely but when the chemicals are in solution, they find entry into porous concrete and react with the hydrated cement products. Of all the sulphates magnesium sulphate causes maximum damage to concrete. A Characteristic whitish appearance is the indication of sulphate attack. The term sulphate attack denote an increase in the volume of cement paste in concrete or mortar due to the chemical action between the products of hydration of cement and solution containing sulphates. In the hardened concrete, calcium sulphoaluminate, forming within the framework of hydrated cement paste. Because of the increase in volume of the solid phase which can go up to 227 percent, a gradual disintegration of concrete takes place.

Another factor influencing the rate of attack is the speed in which the sulphate gone into the reaction is replenished. For this it can be seen that when the concrete is subjected to the pressure of sulphate bearing water on one side the rate of attack is highest.

II. MIX PROPORTION

IS Code Method is used for Mix Design. The final Mix proportion obtained for M30 grade concrete is **1 : 1.21 : 2.77 (W/C is 0.45)**

III. EXPERIMENTAL PROGRAMME

This experimental program consists of the following steps:

- Collection of Materials
- Casting
- Curing
- Testing
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3.1Collection of materials

The constituent materials used in this investigation were procured from local sources. These materials are used after conducting different tests.The materials used are Cement, Flyash, GGBS, Fine aggregate, Coarse aggregate,Water, The compositions in various materials are as follows

Table 1: Chemical Composition of materials

Chemical Constituent	Portland	GGBS	FA
CaO	65%	40%	55%
SiO_2	20%	35%	30%
AI_2O_3	5%	10%	5%
MgO	2%	8%	5%

3.2 Casting

Initially the constituent materials were weighed and dry mixing was carried out for cement, sand and coarse aggregate and admixtures. This was thoroughly mixed manually to get uniform colour of mix. The mixing duration was 2-5 minutes and then the water was added as per the mix proportion. The mixing was carried out for 3-5 minutes duration. Then the mix poured in to the cube moulds of size 150 x 150x 150 mm and then compacted manually using tamping rods.In this paper we mainly Prepared five different mixes of M30 Grade namely conventional aggregate concrete (CAC), concrete made by replacing 20% of cement by Fly Ash (FAC_1), concrete made by replacing 40% of cement by Fly Ash (FAC_2), concrete made by replacing 20% replacement of cement by GGBS (GAC_1) and concrete made by replacing 40% replacement of cement by GGBS (GAC_2).

3.3 Curing

The cubes are demoulded after 1 day of casting and then kept in respective solutions for curing at room temperature with a relative humidity of 85% the cubes are taken out from curing after 7days, 28 days and 60 days for testing.

Curing is a procedure that is adopted to promote the hardening of concrete under conditions of humidity and temperature which are conducive to the progressive and proper setting of the constituent cement. Curing has a major influence on the properties of hardened concrete such as durability, strength, water-tightness, wear resistance, volume stability, and resistance to freezing and thawing.

Concrete that has been specified, batched, mixed, placed, and finished can still be a failure if improperly or inadequately cured. Curing is usually the last step in a concrete project and, unfortunately, is often neglected even by professionals.

Fig 2: Curing of Cubes in sea water

Fig 3: Curing of Cubes in H_2SO_4 solution

We casted 27 cubes of CAC concrete mix, 27cubes of FAC_1 concrete mix, 27 cubes of FAC_2 concrete mix, 27 cubes of GAC_1 concrete mix, 27 cubes of GAC_2 concrete mix. For each concrete mix 9 cubes are kept in three types of curing. These cubes are tested after 7 days, 28 days and 60 days and for testing 3 cubes are tested for specified concrete mix and specified curing.

Fig 4: Curing of Cubes in normal water

3.4Testing

Cubes are tested after completion of curing and for 7days these are tested by UTM with rate of loading 14mpa/min and for 7days, 28 days and 60 days these are tested by CTM with a rate of loading of 14mpa/min

IV. RESULTS & DISCUSSIONS

4.1 Compressive strength studies:

Table 2: **Comparision of Compressive Strengths of Various Concretes cured in normal water**

STRENGTH IN N/mm2	CAC	FAC1	FAC2	GAC1	GAC2
7DAYS	29.82	26.68	27.9	29.54	29.03
28 DAYS	46	48.91	46.35	47.35	45.97
60 DAYS	46.66	49.33	47.46	47.91	46.4

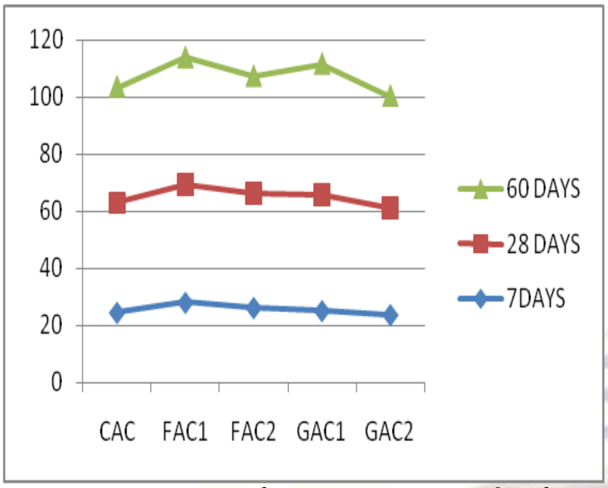

Fig 5: Comparison of Compressive Strengths of Various Concretes cured in normal water

Table 3:Comparison of Compressive Strengths of Various Concretes cured in seawater

STRENGTH IN N/mm2	CAC	FAC1	FAC2	GAC1	GAC2
7DAYS	22.3	21.86	24.77	21.08	22.03
28 DAYS	42.44	39.55	38.92	42.12	40.39
60 DAYS	42.7	43.55	40.24	43.11	41.28

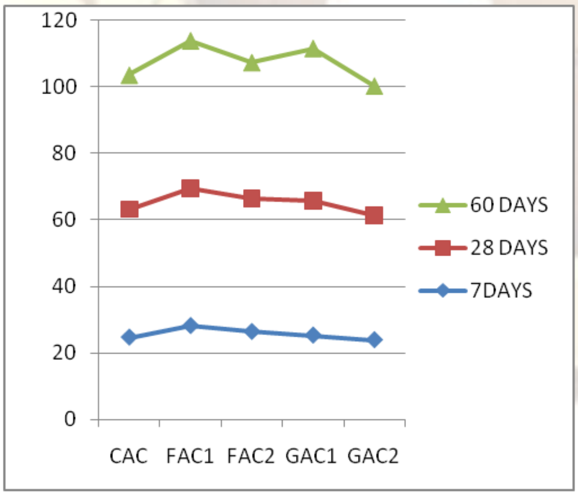

Fig 6: Comparision of Compressive Strengths of Various Concretes cured in seawater

Table 4: Comparision of Compressive Strengths of Various Concretes cured in H_2so_4 solution

STRENGTH IN N/mm2	CAC	FAC 2	FAC1	GAC 1	GAC2
7DAYS	24.68	26.38	28.19	25.3	23.87
28 DAYS	38.43	40.01	41.33	40.44	37.35
60 DAYS	40.44	40.89	44.26	45.78	39.10

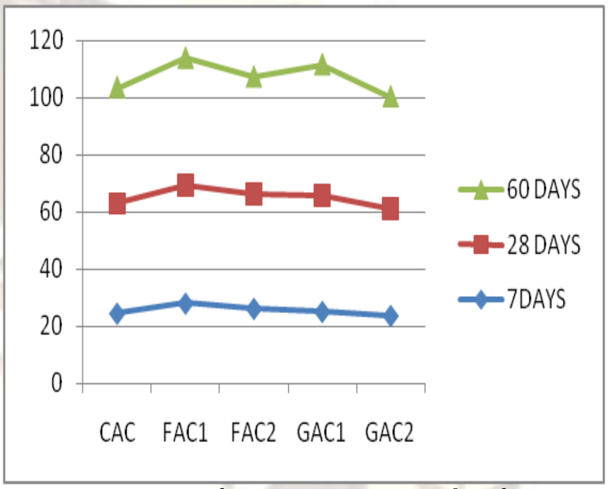

Fig 7Comparision of Compressive Strengths of Various Concretes cured in Sulphuric acid solution

Table 5 Comparison of weight losses when cured in Sea Water:

WEIGHT LOSS(gm)	CAC	FAC1	FAC2	GAC1	GAC2
7DAYS	0	20	35	0	5
28 DAYS	0	35	45	10	15
60 DAYS	0	50	55	20	25

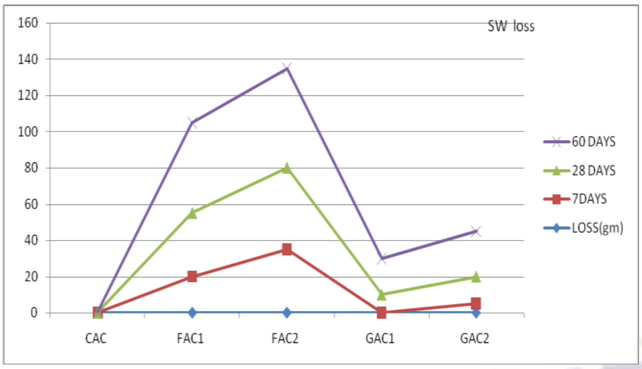

Fig8 Comparsion of Weight losses when cured in sulphuric acid solution

Table 6 Comparison of weight losses when cured in seawater

WEIGHT LOSS(gm)	CAC	FAC1	FAC2	GAC1	GAC2
7DAYS	0	30	40	0	10
28 DAYS	0	45	55	20	35
60 DAYS	0	55	60	40	45

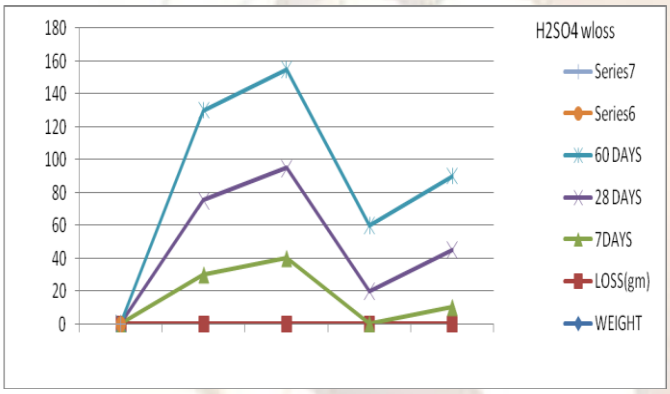

Fig9 Comparsion of Weight losses when cured in sulphuric acid solution

V. CONCLUSIONS

From the experimental work carried out and the analysis of the results following conclusions seem to be valid with respect to the utilization of Fly Ash and GGBS.

- The early strength is compared to less in fly ash and GGBS concretes then conventional aggregate concrete
- The results of fly ash and GGBS concretes when replaced with 20% of cement are more than compared to CAC at the end of 28 days and 60 days for normal water curing
- In sea water curing the GGBS when replaced with 20% of cement shows good response for durability criteria
- In H_2SO_4 solution curing the Fly Ash when replaced with 20% of cement shows good response for durability criteria
- There is no weight loss in case of CAC
- In case of weight loss GGBS offer more resistance than fly ash
- From our experimental work carried out as the strength of fly ash concrete when replaced with 20% cement is increased and the strength of fly ash concrete when replaced with 40% cement is decreased, we recommend the use of fly ash between 20-40% replacement with cement for better results.

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